

GLOSSARY

area: A general term referring to any portion of a *site*, up to and including the entire *site*.

area of elevated activity: An area over which the residual radioactivity exceeds a specified investigation level.

Becquerel (Bq): The International System (SI) unit of activity equal to one nuclear transformation (disintegration) per second. $1\text{ Bq} = 2.7 \times 10^{-11}\text{ Curies (Ci)} = 27.03\text{ picocuries (pCi)}$.

beta particle: An electron emitted from the nucleus during *radioactive decay*.

classification: The act or result of separating *areas* or *survey units* into one of three designated classes: MARSSIM uses Class 1 area, Class 2 area, or Class 3 area.

curie (Ci): The customary unit of radioactivity. One *curie* (Ci) is equal to 37 billion disintegrations per second ($3.7 \times 10^{10}\text{ dps} = 3.7 \times 10^{10}\text{ Bq}$), which is approximately equal to the decay rate of one gram of ^{226}Ra . Fractions of a *curie*, e.g. picocurie (pCi) or 10^{-12} Ci and microcurie (μCi) or 10^{-6} Ci , are levels typically encountered in *decommissioning*.

data life cycle: The process used to describe the flow of data throughout a survey and manage the uncertainty in the survey results so that sound, defensible decisions may be made.

DQA (Data Quality Assessment): The scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support their intended use.

DQOs (Data Quality Objectives): Qualitative and quantitative statements derived from the DQO process that clarify study technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Data Quality Objectives Process: A systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use. The key elements of the process include:

- ! concisely defining the problem
- ! identifying the decision to be made
- ! identifying the inputs to that decision
- ! defining the boundaries of the study
- ! developing the decision rule
- ! specifying tolerate limits on potential decision errors
- ! selecting the most resource efficient data collection design

data quality indicators: Measurable attributes of the attainment of the necessary quality for a particular decision. Data quality indicators include precision, bias, completeness, representativeness, reproducibility, comparability, and statistical confidence.

DCGL (derived concentration guideline level): A derived, radionuclide-specific activity concentration within a *survey unit* corresponding to the *release criterion*. *DCGLs* are derived from activity/dose relationships through various *exposure pathway* scenarios.

decommissioning: The process of removing a facility or *site* from operation, followed by decontamination, and license termination (or termination of authorization for operation) if appropriate.

dose equivalent (dose): A quantity that expresses all radiations on a common scale for calculating the effective absorbed dose. This quantity is the product of absorbed dose (rads) multiplied by a quality factor and any other modifying factors. Dose is measured in *Sv* or *rem*.

exposure pathway: The route by which radioactivity travels through the environment to eventually cause radiation exposure to a person or group.

exposure pathway modeling: An analysis of various exposure pathways used to convert dose or risk into concentration.

exposure rate: The amount of ionization produced per unit time in air by X-rays or gamma rays. The unit of exposure rate is Roentgens/hour (R/h); for decommissioning activities the typical units are microRoentgens per hour ($\mu\text{R/h}$), *i.e.*, 10^{-6} R/h.

external radiation: Radiation from a source outside the body.

final status survey: Measurement and sampling to describe the radiological conditions of a survey unit following completion of decontamination activities (if any) to demonstrate compliance with a release criterion.

gamma (γ) radiation: Penetrating high-energy, short-wavelength electromagnetic radiation (similar to X-rays) emitted during *radioactive decay*. Gamma rays are very penetrating and require dense materials (such as lead or steel) for shielding.

graded approach: The process of basing the level of application of managerial controls applied to an item or work according to the intended use of the results and the degree of confidence needed in the quality of the results.

hypothesis: An assumption about a property or characteristic of a set of data under study. The goal of statistical inference is to decide which of two complementary hypotheses is likely to be true. The *null hypothesis* (H_0) describes what is assumed to be the true state of nature and the *alternative hypothesis* (H_a) describes the opposite situation.

investigation level: A derived media-specific, radionuclide-specific concentration or activity level that : 1) is based on the release criterion, and 2) triggers a response, such as further investigation or cleanup, if exceeded.

measurement: For the purpose of MARSSIM, it is used interchangeably to mean: 1) the act of using a detector to determine the level or quantity of radioactivity on a surface or in a sample of material removed from the media being evaluated, or 2) the quantity obtained by the act of measuring. MARSSIM defines three types of measurements: direct measurements, samples, and scan measurements.

radiation - invisible energy waves or particles given off by unstable atoms as they become more stable by decay. They are most commonly in the form of alpha or beta particles or gamma rays.

risk - probability of incurring injury, disease, or death; often measured in incidence of cancer mortality (age and gender specific or total death rate) or cancer morbidity (age and gender specific or total incidence rate)

radiation level - the intensity of gamma radiation in air or exposure rate typically is measured in Roentgens (R) or microRoentgens (μ R) per unit time, usually an hour, as in R/hr or μ R/hr. In the environment, exposure rates are typically measured in terms of μ R/hr.

radiation dose - effect of radiation on any material is determined by the "dose" of radiation that material receives. Radiation dose is simply the quantity of radiation energy deposited in a material. Several terms used in radiation protection to precisely describe the various aspects associated with the concept of dose and how radiation energy deposited in tissue affects humans: rem - small doses are measured in millirem; one rem = 1,000 millirem. Other countries and scientific community in the U.S. use units called sieverts; one sievert = 100 rem.

radiation survey or radiological survey: Measurements of radiation levels associated with a *site* together with appropriate documentation and data evaluation.

radioactive decay: The spontaneous transformation of an unstable atom into one or more different nuclides accompanied by either the emission of energy and/or particles from the nucleus, nuclear capture or ejection of orbital electrons, or fission. Unstable atoms decay into a more stable state, eventually reaching a form that does not decay further or has a very long half-life.

radioactivity - Whether it emits alpha or beta particles or gamma rays, the quantity of radioactive material is typically expressed in terms of its radioactivity or simply its activity and is measured in curies or becquerels. The mean number of nuclear transformations occurring in a given quantity of radioactive material per unit time. The International System (SI) unit of radioactivity is the *Becquerel (Bq)*. The customary unit is the *Curie (Ci)*. Smaller units are picocuries per gram. Disintegration or counts per time counts per minute (cpm) per unit area are also used. "cpm" refers to the number of ionizing particles striking the detector surface in a unit of time of one minute.

radionuclide: An unstable nuclide that undergoes radioactive decay.

release criterion: A regulatory limit expressed in terms of dose or risk.

remediation: Cleanup or other methods used to remove or contain a toxic spill or hazardous materials.

sample: (As used in MARSSIM) A part or selection from a medium located in a *survey unit* or *reference area* that represents the quality or quantity of a given parameter or nature of the whole area or unit; a portion serving as a specimen.

sample: (As used in statistics) A set of individual samples or measurements drawn from a population whose properties are studied to gain information about the entire population.

scanning: An evaluation technique performed by moving a detection device over a surface at a specified speed and distance above the surface to detect radiation.

site: Any installation, facility, or discrete, physically separate parcel of land, or any building or structure or portion thereof, that is being considered for survey and investigation.

survey: A systematic evaluation and documentation of radiological measurements with a correctly calibrated instrument or instruments that meet the sensitivity required by the objective of the evaluation.

survey unit: A geographical area consisting of structures or land areas of specified size and shape at a remediated site for which a separate decision will be made whether the unit attains the site-specific reference-based cleanup standard for the designated pollution parameter. *Survey units* are generally formed by grouping contiguous site areas with a similar use history and the same classification of contamination potential. Survey units are established to facilitate the survey process and the statistical analysis of survey data.

ACRONYMS AND ABBREVIATIONS

	alpha radiation or the probability of making a Type I decision error
	beta radiation or the probability of making a Type II decision error
	gamma radiation
	delta, the shift, the width of the gray region
/	delta over sigma, the relative shift
	sigma, uncertainty
ANSI	American National Standards Institute
ASQC	American Society for Quality Control
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cpm	counts per minute
DCGL	derived concentration guideline level
DCGL _w	DCGL used with the statistical tests (W = Wilcoxon)
DCGL _{EMC}	DCGL used with the elevated measurement comparison
DOD	Department of Defense
DOE	Department of Energy
DQA	Data Quality Assessment
DQO	Data Quality Objectives
dpm	disintegrations per minute
EMC	elevated measurement comparison
EPA	Environmental Protection Agency
FSS	final status survey
H ₀	null hypothesis
H _a	alternate hypothesis
HSA	Historical Site Assessment
L _c	critical level
L _d	detection limit
LBGR	lower bound of the gray region
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NRC	Nuclear Regulatory Commission
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RSSI	Radiation Survey and Site Investigation (Process)
SOP	standard operating procedure
WRS	Wilcoxon rank sum (test)